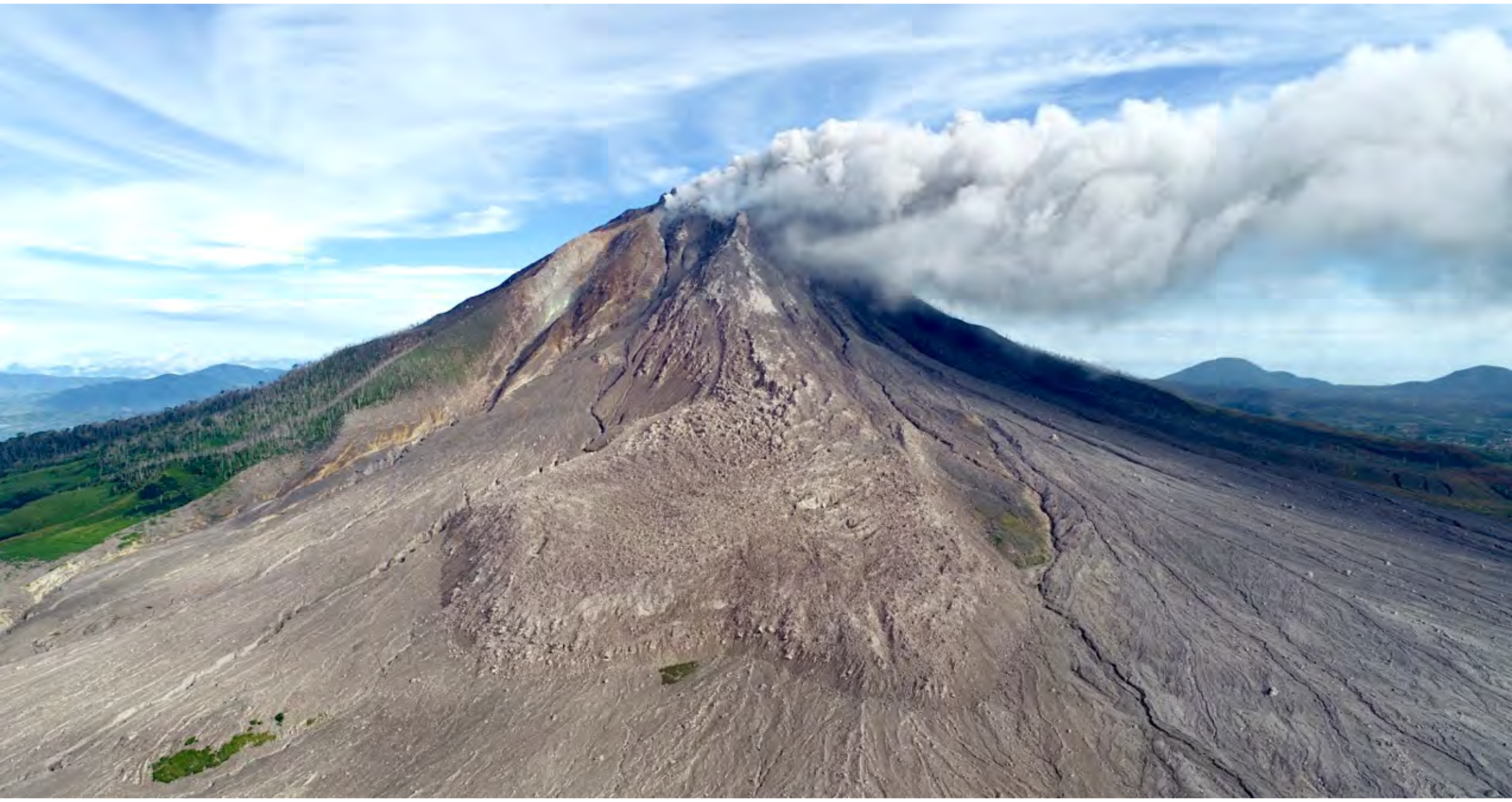


2019 Lamont Postdoctoral Symposium

Photo Credits:

Front Cover:

Top: A small ash-rich explosion at Sinabung Volcano, North Sumatra, Indonesia. Pic: Brett Carr

Bottom: Aboard the R/V Joides Resolution in the South Pacific. Pic: Jennifer Middleton

Back Cover:

A nunatak (rock outcrop) emerges from the Ross Ice Shelf, Antarctica. Pic: Martin Wearing

Inside Back Cover:

Sunrise on the R/V Joides Resolution in the South Pacific. Pic: Jennifer Middleton

From the Office of the Director

Greetings! Welcome to the 2019 Lamont Postdoctoral Symposium. This year participation in the symposium is open to postdoctoral scientists and fellows not just from Lamont-Doherty Earth Observatory (LDEO), but also from the Earth Institute (EI) and the International Research Institute for Climate and Society (IRI). Since its founding in 1949, Lamont has been a leader in the Earth sciences, and our scientists have done groundbreaking and pioneering work not just of physical and fundamental Earth processes but also how these impact human society and our very survival. Today, the need to pay attention to our environment and our planet is more urgent than ever before. When natural events occur with dire consequences and increasing frequency as they have in recent years, be they devastating fires, earthquakes, or tropical storms and hurricanes, we are all reminded that Earth sciences play a central role in human survival and adaptation.

Even as our understanding of Earth improves, new discoveries await us. That next insight on the horizon, that next finding, that next groundbreaking result – these drive our scientists to learn more about the Earth's processes and the impact on human society. Our vibrant, creative, and diverse community of postdoctoral scientists and fellows represents our youngest and newest talent, working towards our goal to develop and communicate new knowledge about the origin, evolution and future of the natural world, and its impacts on human society. Under the guidance of senior scientists, our postdoctoral scientists and fellows are poised to becoming tomorrow's scientific leaders, further advancing our knowledge of the natural world.

We hope that this Postdoctoral Symposium provides you with an overview of the fundamental research carried out by our dynamic group of postdoctoral scientists and fellows.

Sean C. Solomon
Director

Arthur Lerner-Lam
Deputy Director

Kuheli Dutt
Assistant Director
Academic Affairs & Diversity

Lamont Postdoctoral Symposium

Wednesday 11 September 2019 • Comer Seminar Room • Lamont Campus • 10:00 a.m. – 4:00

10:00a – 10:05a **Welcome Note**
Sean C. Solomon, Director, LDEO

10:05a – 11:15a **Marine Geology & Geophysics Division (MGG)**
Presenters: Patrick Alexander, Julen Alvarez-Aramberri, Renata Constantino Barrella, Brian Boston, Laura Stevens, Martin Wearing

Seismology, Geology & Tectonophysics Division (SGT)
Presenter: Mark Hoggard

11:15a – 11:30a **Coffee Break**

11:30a – 12:40p **Geochemistry Division**
Presenters: Juan Carlos de Obeso, Jennifer Middleton, Paulina Pinedo

Biology & Paleo Environment Division (BPE)
Presenters: Kasey Bolles, Jacqueline Goordial, Winslow Hansen, Rachel Lupien, Milagros Rodríguez-Catón

12:40p – 1:40p **Lunch**

1:40p – 2:30p **International Research Institute for Climate & Society (IRI)**
Presenter: Weston Anderson

Ocean & Climate Physics Division (OCP)
Presenters: Spencer Jones, Kai Kornhuber, Rick Russotto, Honghai Zhang

2:30p – 4:00p **Poster Session over Coffee and Dessert**
Geochem: Erin Black, Julia Gottschalk, Sophie Hines, Naomi Saunders, Lauren Kipp, Ross Whiteford, Yingzhe Wu
SGT: Brett Carr, Seth Saltiel
OCP: Spencer Hill, Luke Schiferl, Shujie Wang, Mu Xu

Oral Session Abstracts

Constraining and Quantifying Effects of Glacier Surface Albedo in a Global Climate Model Simulation

Patrick Alexander et al, Marine Geology & Geophysics

The surface albedo of glaciers plays an important role in their response to changes in climate, enhancing melt and contributing to positive surface melt-albedo feedbacks. While regional climate models (RCMs) used over polar regions generally include a fairly detailed representation of glacier surface albedo, global climate models (GCMs) used to project future changes in climate often simply apply a fixed albedo over glaciated areas, ignoring feedbacks between the atmosphere and ice surface. I will present work focused on improvements to the simulation of ice sheet surface albedo in the NASA Goddard Institute for Space Studies (GISS) GCM, in particular the introduction of a new scheme for snow and ice albedo based on the Snow, Ice, Atmosphere Radiative Transfer Model (SNICAR), a leading model used to represent snow albedo. Sensitivity simulations over the Greenland ice sheet illustrate the strong impact of surface albedo on ice sheet surface mass balance, with a satellite-derived surface albedo increasing simulated melt by 60-100% relative to a fixed albedo scheme.

Numerical Challenges in Marine Electromagnetics Modeling

Julen Alvarez-Aramberri, Marine Geology & Geophysics

Controlled Source Electromagnetic (CSEM) and Magnetotelluric (MT) methods are Earth exploration techniques based on electromagnetic (EM) measurements. Active and passive time-harmonic sources produce EM fields, that are governed by Maxwell's equations. Depending upon the subsurface resistivity (or conductivity) and the source frequency, these EM fields penetrate the Earth's subsurface a distance that ranges between tens of meters and hundreds of kilometers. It is possible, then, to obtain a map of the Earth's resistivity distribution by recording these fields at several receivers, which are placed on the Earth's surface (or at the seafloor). When using a Finite Element (FE) method to model these kinds of problems, different numerical challenges arise. Some of them include: the correct truncation of the computational domain, the strategy for building the FE grid, the decision of which equations to solve, or the possibility of designing forward solvers that take into account different dimensionalities of the Earth simultaneously.

Seafloor Depth of George VI Sound, Antarctic Peninsula, using Operation IceBridge Aerogravity

Renata Constantino Barrella, Marine Geology & Geophysics

The George VI Sound on the west coast of the southern Antarctic Peninsula separates Alexander Island from Palmer Land. The Sound is a geologically complex region, covered by an ice shelf. Little is known about the seafloor under the ice except for 8 seismic profiles from the 1980s. To estimate bathymetry, we use gravity and ice thickness data from Operation IceBridge (OIB) campaigns along 25 profiles over the Sound. All available bathymetric information from seismic measurements is used to constrain the model. We also propose a simplified crustal structural model of the study area. The Sound has two morphological regions: the northern section, between 20 and 35 km wide, trending NNW-SSE and the southern section, where it widens suddenly to 60 km and gradually increases in width to 90 km as it curves SW, following the Palmer Land Coast. Our results show a deeper channel for southern profiles, with depths up to 1000 m, shallowing northwards. A simple crustal model is set for all the profiles with densities of 3.2 gm/cm^3, 2.9 gm/cm^3 and 2.7 gm/cm^3 for mantle, lower crust and upper crust, respectively. Furthermore, less dense sedimentary material with density of 2.4 gm/cm^3 is set for the entire Sound between sea level and 2 km depth, with distribution varying long profiles. A denser body at depths of 2.0 – 4.2 km on the Palmer Land side is defined between southern and northern section, which could be related to a previously identified major fault along the eastern coast line.

Oral Session Abstracts

Making Northern Zealandia: The Breakup of Eastern Gondwana

Brian Boston, Marine Geology & Geophysics

Eastern Gondwana breakup through continental rifting in the Late Cretaceous isolated Zealandia, a 94% submerged ribbon of continental crust, from eastern Australia. Because the processes that led to this asymmetric breakup are poorly constrained, we used multi-channel seismic reflection data and wide-angle seismic velocity constraints to determine how the continental rifting and breakup occurred in northern Zealandia. These results show a sliver of oceanic crust in the Middleton Basin is surrounded by the continental blocks of the Dampier Ridge and Lord Howe Rise. The sediment depositional pattern between these continental blocks indicates that the breakup of eastern Gondwana first started at the Middleton Basin and later jumped to the west to open the Tasman Basin. Multibeam bathymetry and seismic data show that the Dampier Ridge expresses a range of seafloor features that contrast the largely featureless seafloor of the Lord Howe Rise. The pattern of syn-rift fault strikes on the Dampier Ridge is similar to what has been inferred from previous work on the Lord Howe Rise and suggests a regional stress change linked to a two-stage breakup of eastern Gondwana.

Melt Forcing of Helheim Glacier Diurnal Velocity Fluctuations

Laura A. Stevens et al., Marine Geology & Geophysics

The influence of surface melt on the flow of Greenland's largest outlet glaciers remains poorly known. We employ a stochastic-filter approach to estimate time-varying velocities across geodetic arrays deployed on East Greenland's Helheim Glacier during two summer seasons. We observe diurnal variations in glacier speed, distinct from ocean-tide responses and background flow, that peak ~6.5 hours after peak daily melting. We hypothesize that surface meltwater transits through an active englacial hydrologic system to the ice-bed interface, where it reduces resistance to basal slip. Both the amplitude of the diurnal speed variation and its sensitivity to daily melt are largest at the glacier terminus and decrease upglacier, suggesting that the magnitude of the melt response is controlled not only by the volume of melt input, but also by a background effective pressure condition that remains fixed near zero close to the glacier's marine margin.

Ice-shelf Secondary Flow Counteracts the Growth of Basal Melt Channels

Martin Wearing, Marine Geology & Geophysics

Ice-shelf basal channels form due to concentrated melting at the base of floating ice shelves. Basal channels are present in many Antarctic ice shelves and can reduce ice-shelf structural integrity, potentially incising through the entire ice thickness. Here, we describe the viscous ice response to the presence of a basal channel – secondary flow – which acts perpendicular to the channel axis and is induced by the gradient in ice thickness. We show analytically how secondary flow increases with channel height and the slope of channel sidewalls. We use a numerical ice flow model to test the analytical approximation and demonstrate how secondary flow reduces the rate of channel incision and increases the time until complete incision through the ice shelf. In some cases, a steady-state geometry can exist even while melt continues. We demonstrate that future basal-channel size cannot be estimated by assuming constant growth rate.

Treasure Maps, Sustainable Development, and the Billion-Year Stability of Cratonic Lithosphere

Mark Hoggard, Seismology, Geology & Tectonophysics

Sustainable development and transition to a clean-energy economy is placing growing demands on global supplies of base metals (copper, lead, zinc, nickel). Alarmingly, this demand is outstripping the present rate of discovery of new deposits, with significant shortfalls forecast in the future. To maintain growth in global living standards, dramatic improvements in exploration success rate are essential. Significant quantities of base metals have been deposited by low-temperature hydrothermal circulation within sedimentary basins over the last 2 billion years. Despite over a century of research, relationships between these deposits and geological structures remain unclear. Here, for the first time, I will show that 85% of sediment-hosted base metals, including giant deposits (>10 mega tonnes of metal), occur within 200 km of the edges of thick lithosphere, as mapped using surface wave tomography and parameterisation for anelasticity at seismic frequencies. This observation implies long-term lithospheric edge stability and a genetic link between deep Earth processes and near-surface hydrothermal mineral systems. This result provides an unprecedented global framework for identifying fertile regions for mineral exploration, reducing the search-space for new deposits by two-thirds on this lithospheric thickness criterion alone.

Hydrothermal Interference in Marine Depositional Records of Climate Variability

Jennifer Middleton et al, Geochemistry

Mid-ocean ridges are a valuable open-ocean environment for the recovery and construction of sedimentary flux records of terrigenous dust, biogenic material, and hydrothermal precipitates. Such records constrain the atmospheric and oceanographic responses to climatic variability and are used to investigate the relationship between sea level change and submarine volcanic activity. Extraterrestrial helium-3 ($^{3}He_{ET}$) and excess thorium-230 ($^{230}Th_{XS}$) are used to constrain vertical sediment fluxes independent of lateral sediment transport and age model resolution. However, hydrothermal scavenging of $^{230}Th_{XS}$ may complicate its utility in mid-ocean ridge settings. Here we examine the performance of $^{230}Th_{XS}$ in constraining sediment fluxes in cores from the Mid-Atlantic Ridge and the Juan de Fuca Ridge. We find that the magnitude and spatial scale of hydrothermal influences on $^{230}Th_{XS}$ systematics vary as a function of ridge bathymetry and hydrothermal intensity, as well as temporally, amongst ridge segments. In the most affected sediments, $^{230}Th_{XS}$-derived records are distorted and yield fluxes 2-5 times higher than those derived using $^{3}He_{ET}$. We recommend the utilization of $^{3}He_{ET}$ to constrain sedimentary fluxes in regions for which the extent of hydrothermal $^{230}Th_{XS}$ scavenging has not yet been characterized.

Jennifer Middleton holding cores from the Southern Ocean, from IODP Expedition 383. Pic: Julia Gottschalk

Oral Session Abstracts

Carbonation and Serpentinization in the Shallow Mantle Wedge of a Fossil Subduction Zone: Oman Drilling Project Hole BT1B

Juan Carlos de Obeso et al, Geochemistry

Oman Drilling Project hole BT1B drilled 300 meters through the basal thrust of the Samail ophiolite. The first 200 meters are dominated by listvenites (carbonated peridotites) and serpentinites. Below 200 meters the hole is mainly composed of metasediments and metavolcanics. This core provides a unique record of interaction between peridotite in the leading edge of the mantle wedge and hydrous, CO_2-rich fluids derived from subducting lithologies. Using a variety of geochemical compositions and isotope systems (C, Mg and Sr) along with geochemical modeling we are unraveling the complex alteration history of the mantle wedge just above the slab interphase in a fossil subduction zone.

Anthropogenic Asian Aerosols provide Fe to the North Pacific

Paulina Pinedo, Geochemistry

Iron is a globally important micronutrient which is known to limit phytoplankton productivity in much of the world ocean. The deposition of mineral dust in aerosols is considered the primary source of Fe to the surface ocean, yet recent work has suggested that anthropogenic processes may contribute to aerosol Fe. Atmospheric models generally reproduce similar patterns and quantities of Fe deposition to the oceans, but they differ greatly on whether anthropogenic Fe is a significant source of Fe to the oceans, with estimates of the fraction of soluble Fe delivered from anthropogenic emissions ranging from insignificant to supplying well over half of the global supply of aerosol Fe. This study presents results from a field campaign in 2018 following a latitudinal transect at 157° W from 21° to 42° N in the North Pacific. Iron isotope data, with high-resolution analyses of other metals, show the first *in situ* evidence of anthropogenic Fe in seawater. This suggests that anthropogenic fossil fuel burning may be delivering Fe to the iron-limited North Pacific, impacting phytoplankton productivity and carbon cycling, changing our understanding of how anthropogenic fossil fuel combustion affect the global oceans.

LC-130 Hercules at Williams Field, Ross Ice Shelf, Antarctica. Pic: Martin Wearing

Oral Session Abstracts

Frequency and Trends of Central U.S. Flash Drought Since 1490

Kasey Bolles et al., Biology & Paleo Environment

In the central United States (CUS), rapid intensification of drought conditions, i.e. a "flash drought," often results in severe and complex impacts on water availability and warm-season agricultural productivity, such as in 2012. Flash droughts are challenging to predict given their subseasonal occurrence, but with the potential for disastrous longer-term effects, improved ability to detect and forecast such events is a pressing need. Flash droughts are often driven by atmospheric ridges that block storms and increase temperatures. In CUS, such anomalies are most acute during the climatological rainy season that occurs in late spring to early summer (MJJ). Here we utilize a network of tree-ring records to reconstruct MJJ mid-continental atmospheric ridging anomalies that inhibit precipitation and promote exceptional heat. We present this atmospheric reconstruction in tandem with a new reconstruction of MJJ soil moisture. The resulting reconstructions span CE 1490 to 2017, extending observational records of flash drought events by over 400 years. Exploratory analyses reveal the frequency and trends in the co-occurrence of MJJ drought and ridging events over the last ~530 years, including during the late 16^{th} century megadrought. We examine the range of variability associated with flash drought events and assess the propensity for ridging anomalies over the continental interior. This novel reconstruction of atmospheric ridging and flash drought improves our understanding of the range of natural variability of these events in terms of intensity and frequency, and will motivate further work to understand the dynamical drivers of CUS flash droughts.

Fate of Ancient Carbon Caused by Permafrost Coastal Erosion into Marine Environments

Jacqueline M. Goordial, Biology & Paleo Environment

Permafrost contains the worlds largest reservoir of carbon, and accounts for 34% of the worlds coasts. Currently, Arctic warming resulting in longer open water seasons and sea level rise are leading to increased rates of coastline degradation as high as 20 meters per year. As a result, permafrost coastline erosion is delivering large amounts of aged organic carbon and nutrients into nearshore marine environments, abruptly, and irreversibly. Estimates of the annual release of terrestrial organic carbon from degrading permafrost coastline have large uncertainties (~14.0 – 44.0 Tg C) but is the same order of magnitude as the input from riverine transport, or from methane emissions as a result of active layer thaw. My work will investigate the fate of organic carbon stored in coastal permafrost when delivered to nearshore environments, to understand how variation in seawater nutrients and seasonality of erosion (winter vs. summer temperature and light conditions) may impact the amount of greenhouse gases (CO_2 and CH_4) evolved, to better understand the potential for a positive feedback loop as a result of coastal erosion, as well as the potential effects on local food webs and biogeochemical cycles which are driven by microbial processes.

View from Castle Rock, Ross Island, Antarctica. Volcano Mt. Erebus can be seen on the horizon to the right. Pic: Martin Wearing

Oral Session Abstracts

Global Hotspots of Forests Primed to Climate Variability

Winslow D. Hansen, Earth Institute, Biology & Paleo Environment

Earth's forests are often very sensitive to changes in short-term climate variability. As climate change accelerates, however, it has been difficult to predict where and when forests will be stressed because patterns of climate variability are complex and differ across forest biomes. To address this, we propose the forest priming hypothesis: Trees in forests where past climate was more variable will have developed wider thermal and/or hydrologic tolerances that prime them to better cope with changes in subsequent climate variability. We tested this hypothesis by evaluating how variability in forest structure and function (measured by gridded annual maximum Enhanced Vegetation Index) changes with variability in temperature, precipitation, and vapor pressure deficit. We found that forest sensitivity declined as inter-annual climate variability increased across and within boreal, temperate, and tropical biomes. Boreal forest was particularly primed to cope with variable temperature, and temperate forest was primed to precipitation and VPD. Tropical forests did not show strong evidence of priming, highlighting how some of the most biodiverse and carbon-rich ecosystems on earth, may be particularly sensitive.

Orbital-Scale Controls on Plio-Pleistocene East African Climate

Rachel Lupien, Biology & Paleo Environment

Orbitally-induced insolation changes, ice-sheet extent, greenhouse gas concentrations, and tectonic events are all hypothesized to have affected East African hydroclimate on long timescales. Evaluating impacts of these forcings has been challenging due to the lack of long, high-resolution hydroclimate records. Here we synthesize new hydroclimate records based on the hydrogen isotopic composition of terrestrial leaf waxes (δD_{wax}) preserved in drill cores from multiple East African paleolakes that together span key intervals of the last 3.3 million years. We suggest that the establishment of large permanent ice sheets at ~2.8 Ma influences tropical hydroclimate, through southward displacement of the tropical rain belt or through a threshold response to global cooling. Precession-band variability is found throughout the Plio-Pleistocene, but after ~150 ka, a 100-kyr sawtooth pattern is apparent. The lack of mid-Pleistocene obliquity variations, together with 100-kyr variability in the late Pleistocene, indicates threshold responses to global climate boundary conditions associated with glacial-interglacial variations.

Reconstructing Temperature Variability for the South American Altiplano Region Using Isotope Tree-Ring Chronologies

Milagros Rodríguez-Catón et al, Biology & Paleo Environment

In the last decades, the Central Andes is experiencing a persistent warming and drying trend, together with an increasing demand for water resources. The scarcity of reliable and long instrumental climate data have prevented to place the current warming in a long-term context. Tree rings provide information about past climate variability and a better understanding of the full range of climate variability (annual, decadal and centennial). Here, using a newly developed $\delta^{18}O$ tree-ring we reconstruct temperature variability in four distinct sites across the Altiplano, a high altitude plateau in the Andes. The $\delta^{18}O$ isotope chronologies were obtained from wood material of *Polylepis tarapacana,* the highest elevation tree species worldwide and the longest living species near the tropics in South America. The sites are located at about 4400 m asl along a latitudinal gradient. The $\delta^{18}O$ chronologies cover a period of 60 years (1950-2008) overlaping with the instrumental data for the region. While ring-width chronologies show a positive and negative response to temperature during current and previous growing season, respectively, we found positive relationships between $\delta^{18}O$ and mean regional temperature, for both current and previous growing season. The results obtained in this study show a great potential of *Polylepis tarapacana* $\delta^{18}O$ from tree-rings to reconstruct climate variability with annual resolution for the last millenia.

Oral Session Abstracts

Does the Madden-Julian Oscillation Affect Crop Yields?

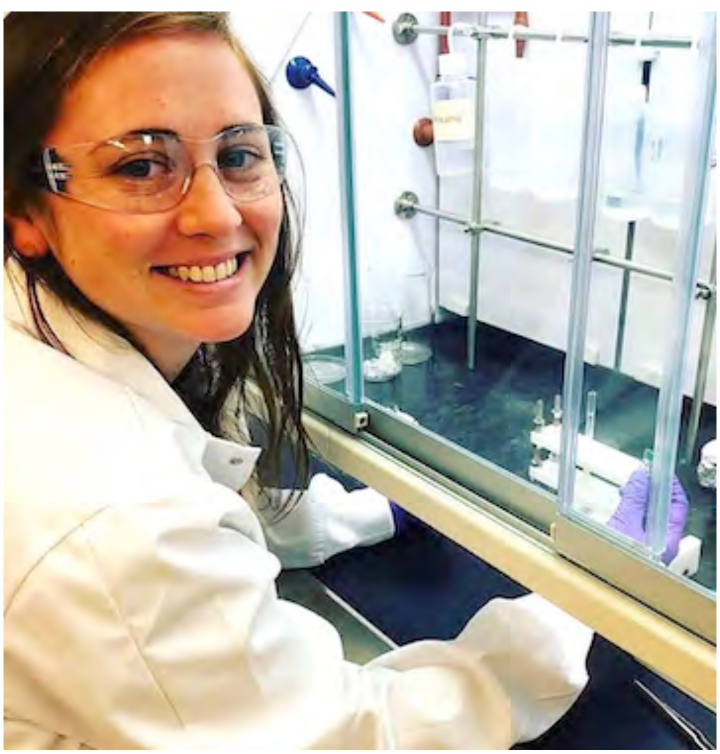
Weston Anderson, Earth Institute, International Research Institute for Climate & Society

Climate variability plays a leading role in determining regional and global crop yield variability. Considerable research has demonstrated the mechanisms by which interannual modes of climate, such as the El Niño Southern Oscillation (ENSO), affect seasonal growing conditions and subsequently crop yields. But crop yields are also strongly affected by shorter duration stresses. Just a few hours exposure to excessive heat can significantly reduce final crop yields or, in the case of extreme heat, can cause complete sterility. Despite the widely recognized role of short-duration stresses in damaging crop yields, there is no research on how intra-annual climate modes, the most prominent of which is the Madden-Julian Oscillation (MJO), affect agriculture. Here we present evidence that the MJO forces agriculturally-relevant teleconnections that affect crop yields throughout the tropics using both observational and model-based yield estimates.

Isopycnal Mixing and Ventilation of the Deep Ocean

Spencer Jones, Ocean & Climate Physics

Climate models often parameterize isopycnal mixing by mesoscale eddies using a diffusion operator that acts in the along-isopycnal direction, multiplied by an isopycnal-mixing coefficient. The magnitude of this coefficient is highly uncertain, with observational estimates ranging from 12 m^2/s to 10,000 m^2/s. In an idealized-geometry ocean model, the isopycnal-mixing coefficient is varied across a similar range: this leads to large changes in the ventilation of the deep ocean. Passive tracers are used to assess the impact of varying the isopycnal-mixing coefficient on the distribution of water masses. Increasing the isopycnal-mixing coefficient from 50 m^2/s to 5000 m^2/s leads to a 42% reduction in the amount of North Atlantic Deep Water and a 129% increase in the amount of Antarctic Bottom Water present in the deep Pacific ocean. This change is associated with an 700 year reduction in the ideal age of the water in the deep Pacific ocean.



Above: Rachel Lupien in her lab.
Right: Julen Alvarez-Aramberri on a research cruise to the Gulf of Alaska

Oral Session Abstracts

Circumglobal Rossby Waves Enhance Risk of Simultaneous Heat Extremes in Major Breadbasket Regions

Kai Kornhuber, Earth Institute, Ocean & Climate Physics

In a strongly interconnected world, coincident extreme weather events in far-away regions could potentially pose high risks for societies. In the mid-latitudes, amplified Rossby-waves associated with a strongly meandering jet-stream might cause co-occuring heatwaves and floods across the northern hemisphere (NH). Here we analyze circum-global Rossby-waves in boreal summer and show that those with wavenumber 5 and 7 have a preferred phase position, thus constituting recurrent circulation patterns. Those patterns relate to simultaneous heat extremes in specific regions, identified as Central North America, Eastern Europe and Eastern Asia (wave-5) and Western North America, Western Europe and Western Asia (wave-7). We find that the chance of simultaneous heat events in these regions increases by a factor of 20 and 24 during the occurrence of the wave-5 and wave-7 pattern. We show that the 2018 extremes were connected by the identified wave-7 pattern, also observed during the European heatwaves of 2003, 2006 and 2015 among others. We show that this circum-global circulation pattern has increased in frequency and persistence in recent years and discuss possible mechanisms. Given the high impacts of these extremes to human society, this presents major risks for global food production in particular, since the main breadbasket regions are located in the mid-latitudes.

Lava erupting from multiple fissure vents during the 2018 eruption of Kīlauea Volcano in Hawai`i. Pic: Brett Carr

Oral Session Abstracts

Rapid Adjustments, Climate Feedbacks and Polar Amplification in a Multimodel Aquaplanet Ensemble

Rick Russotto, Ocean & Climate Physics

The Tropical Rain Belts with an Annual cycle and Continent Model Intercomparison Project (TRACMIP) contains an ensemble of aquaplanet simulations that present a unique opportunity to study climate feedbacks and the polar amplification of warming. The Aqua4xCO2 experiment, in which atmospheric CO2 is abruptly quadrupled in each model, represents an analogue to the CMIP5 Abrupt4xCO2 experiment with no continents, sea ice, or ocean dynamics but retaining a seasonal cycle and a prescribed ocean heat transport mimicking the real Earth. We use established methods to calculate various rapid adjustments and feedbacks in the Aqua4xCO2 ensemble, and estimate the contributions of each to meridional energy transport and polar amplification using a moist energy balance model. The SW cloud feedback, which is among the largest contributors to inter-model spread in polar amplification, is characterized by a dipole related to shifts in the tropical rain belt, and it is generally opposed in sign to the SW cloud rapid adjustment, indicating that the rain belt initially shifts in one direction before reversing this effect as the planet warms. We relate these energetic calculations to the changes in physical cloud properties, and compare our results to those from CMIP5 studies to shed light on which common aspects of climate feedbacks and the meridional pattern of warming are persistent when features like land and sea ice are removed.

Ocean Intensifies June Extreme Rainfall over Southwestern North America

Honghai Zhang, Ocean & Climate Physics

Extreme rainfall over Southwestern North America (SWNA) has been mostly investigated during wet seasons, while little attention has been paid to extreme rainfall during dry seasons despite its vital importance for sustaining ecosystems. Here we examine the top 1% rainfall over SWNA in June, the driest month on average, and assess how it is affected by ocean with a 50km-resolution global climate model. Comparing millennia-long simulations with and without ocean variability, we find that ocean does not change the pattern and magnitude of atmospheric circulation associated with June extreme rainfall, but significantly enhances its intensity. This intensification is attributed to a larger variability of atmospheric moisture content enhanced mainly by the tropical Pacific. These results imply that the predictability of occurrence of June extreme rainfall over SWNA is limited by atmospheric intrinsic dynamics, while reliable predictions of its intensity require a faithful simulation of ocean variability.

A field site in Alaska. Pic: Luke Schiferl

Poster Session Abstracts

Tracking the Biological Carbon Pump in the Arctic Ocean

Erin E. Black, Geochemistry

Unprecedented changes in sea surface temperature, ice cover, and marine productivity have been observed in the Arctic over the last two decades. Measures of particulate carbon export are vital to an assessment of potential shifts in the efficiency and strength of the biological carbon pump that could result from these changes. Thorium-234, Thorium-228, and Thorium-230 are naturally occurring radioisotopes whose disequilibrium with parents Uranium-238, Radium-228, and Uranium-234 can be used with particulate carbon measurements to quantify how much carbon leaves the upper ocean and is effectively sequestered at depth. Preliminary estimates of upper ocean carbon export (0-200 m) from the U.S. GEOTRACES Arctic campaign suggest that there has been little to no change in the biological pump in the oligotrophic central Arctic Ocean. While these shallow data indicate that the Arctic's biological pump is still 'weak' by global ocean standards, we also observe unusual subsurface maxima in particulate thorium and deep, broad remineralization features. Utilizing all existing radioisotope and sediment trap export estimates from this region, we explore the possibility that the Arctic biological carbon pump is changing and functioning in a way that is unique to this ocean basin.

The Role of the Westerlies and Atlantic Overturning in Millennial-Scale Atmospheric CO_2 Variations: A Model Compilation

Julia Gottschalk et al, Geochemistry

Climate model simulations are an important tool to understand the processes and feedbacks in the Earth's climate system responsible for changes in atmospheric CO_2 ($CO_{2,atm}$). A wealth of model simulations predicts a wide range of $CO_{2,atm}$ changes for a number of different types of forcing (and combinations thereof). Here, we present a systematic compilation of model simulations that investigate millennial-scale changes in $CO_{2,atm}$ levels as a result of freshwater hosing in the North Atlantic and Southern Ocean, and changes in the strength and position of the southern-hemisphere westerlies. Our compilation shows consistent trends in simulated changes in $CO_{2,atm}$ across different climate models in most cases, but the mechanisms driving these trends may differ among the simulations. Our model compilation provides a comprehensive indication of the direction of simulated $CO_{2,atm}$ change in climate models forced with a particular type of forcing, but does not allow a prediction of realistic $CO_{2,atm}$ amplitude changes during past millennial-scale climate events. More research is required to assess possible interactions between southern-hemisphere westerly wind shifts and Atlantic overturning, and effects on simulated $CO_{2,atm}$ concentrations, and to determine the sensitivity of the model outcome to climate boundary conditions.

Nickel Stable Isotopes – A Proxy for Mantle Recycling?

Naomi. J. Saunders et al., Geochemistry

Investigation of Ni isotopic compositions has accelerated in the last 5 years, with increased interest expressed in ~20 published papers in that time period. Recent work has shown early indications of Ni isotopic fractionation in the Earth's mantle in high temperature terrestrial systems. My recent work, analysed using double spike and MC-ICPMS at Oxford, has extensively shown heterogeneity exists within the mantle, but that there is no significant fractionation between mantle phases. Nickel isotopic heterogeneity is most extreme in pyroxenitic lithologies. Nickel isotope data for terrestrial mafic rocks shows no δ^{60}Ni fractionation with different degrees of partial melting, and no evidence is seen for partial melting or fractional crystallisation having an effect on δ^{60}Ni in other samples. Fresh axial MORB glasses display curvilinear trends that extend from mantle-like δ^{60}Ni to light δ^{60}Ni associated with LREE enrichment, negative Eu anomalies, high Rb/Sr, and high K_2O/total alkalis. A simple mixing model can reproduce these relationships. These data suggest that ocean basalts preserve heterogeneity in their δ^{60}Ni compositions that relates directly to heterogeneity in their mantle source regions. One explanation is that this reflects proportions of the mantle source region enriched by material recycled by subduction.

Poster Session Abstracts

Glacial Overturning Circulation Structure and Agulhas Leakage from Nd Isotope and K/Ar Measurements in the Cape Basin

Sophie Hines, Geochemistry

The Agulhas Current is the largest western boundary current in the ocean, transporting roughly 70 Sv of warm salty water along the southeastern coast of Africa. As this current reaches the tip of South Africa, it retroflects and turns sharply back to the east, joining the Antarctic Circumpolar Current, while shedding eddies into the Atlantic Ocean. These eddies comprise the Agulhas Leakage, which carries between 5 and 20 Sv of water and is the warm return route for the meridional overturning circulation. The flux of salt into the Atlantic via the Agulhas Leakage aids in the formation of North Atlantic Deep Water (NADW). We have reconstructed changes in deep ocean circulation in the Cape Basin over the last glacial cycle using neodymium isotope measurements on sediments from IODP site U1479 (2615 m). In the deep ocean, neodymium isotopes track mixing between North Atlantic and Pacific endmembers, and in the modern ocean this site is bathed in remnant NADW. We combine neodymium isotope measurements from U1479 with published neodymium measurements from nearby cores that sit shallower and deeper in the water column thus allowing us to reconstruct changes in the vertical structure of water masses in this region and make inferences about changes in overturning circulation across the last glacial cycle

Brian Boston emerging from the Otainai Caves near Mt. Fuji, Japan.

Brett Carr on the summit of Merapi Volcano, Java, Indonesia

Poster Session Abstracts

Distribution of Neodymium Isotopes along the GEOTRACES Eastern Pacific Zonal Transect (GP16)

Yingzhe Wu et al., Geochemistry

The GEOTRACES Eastern Pacific Zonal Transect (EPZT, GP16) provides a great opportunity to understand sources, sinks and cycling of neodymium (Nd) in the ocean as well as how well Nd isotopes behave as a conservative water mass tracer because the EPZT crosses different environments, including a continental margin, an oxygen minimum zone, an oceanic ridge, and open ocean. We report the distribution of dissolved Nd isotopes from 21 stations along the EPZT. Most of the surface samples (0-10 m) show ε_{Nd}-values between -2 and -1, reflecting terrigenous contributions from South America. In the middle part of the EPZT, it consistently shows ε_{Nd}-values of PDW (ε_{Nd} = -4) below 500 m. In the far west, below 500 m, ε_{Nd}-values gradually decrease with depth, indicating contributions from the southern-sourced AAIW, CDW, and AABW (ε_{Nd} = -8 to -7). Near the Peruvian margin, between 500 and 2000 m, seawater shows higher ε_{Nd}-values compared to water at the same depth in other stations, which could be attributed to contributions from marginal sediments. These results indicate that Nd isotopes in the open ocean largely behaves as a conservative water mass tracer, while deviations from conservative behavior are evident close to continental margins.

Mapping and Classification of Volcanic Deposits using Multi-Sensor Unoccupied Aerial Vehicles

Brett Carr, Seismology, Geology & Tectonophysics

The deposits of volcanic eruptions represent the record of activity from a given eruption and volcano. Identification and interpretation of these deposits is crucial to the understanding of volcanic processes and assessing hazards. However, deposits often cover large areas and are difficult to access, making field mapping difficult or inefficient. Remote sensing techniques have become increasingly popular as a means to map and identify the deposits of volcanic eruptions, though these techniques present their own trade-offs in terms of image resolution, wavelength, and ground-truth. We present a new method for mapping volcanic deposits using a multi-sensor unoccupied aerial vehicle (UAS). We use a visual camera and structure-from-motion photogrammetry to create digital elevation models (DEMs) of the surface and repeat surveys with a thermal infrared (TIR) camera to calculate the solar heating rate of the surface. We find that by contrasting the roughness and heating rate of the deposit surface, we can remotely classify different lava flow morphologies and pyroclastic deposits from the recent eruption of Volcán Sierra Negra (Galápagos, Ecuador). This new method demonstrates the ability to use UAS for mapping volcanic deposits in high-resolution over relatively large areas.

'Bristle-state' Friction: Alternative Rate and State Dependent Frictional Constitutive Relation Simulates High-Velocity Experiments Towards a Loading-Independent Universal Friction Law

Seth Saltiel, Seismology, Geology & Tectonophysics

During earthquake rupture the fault interface experiences a multi-staged frictional evolution, including initial strengthening, weakening, and healing. Measurements of these stages under realistic co-seismic slip-rates of meters per second are only fit by direct parameterizations without internal state variable dependence needed to simulate arbitrary slip-histories. Commonly used forms of rate-state friction based on low-velocity, step-change experiments cannot fit high-velocity slip-pulse measurements. We introduce 'bristle-state' friction models, developed by control-systems engineers to predict the frictional evolution during arbitrary stressing, especially transitions from static regimes. To isolate the influence of friction, we assume the driving velocity is applied directly to the interface, allowing an analytical solution for state. Although designed for low-velocity experiments, we show that the bristle-state form can fit high-velocity, non-trivial slip-rate histories, suggesting adapted state dependent models could provide a path towards a universal constitutive law, connecting observations across loading conditions.

Poster Session Abstracts

Activity and Hazards of the Ongoing Eruption of Sinabung Volcano, Indonesia, Evaluated Using UAS-Derived Datasets

Brett Carr, Seismology, Geology & Tectonophysics

Sinabung Volcano, located in North Sumatra, Indonesia, has been erupting continuously since late 2013. Activity has generally been effusive, though the style has varied considerably and included the emplacement of a 3 km long andesitic lava flow, frequent lava dome collapses, and periodic ash-rich explosions. We applied structure-from-motion photogrammetry to visual images captured by an unoccupied aerial system (UAS) in June 2018, and data from previous field work in 2014, to describe the current state of activity at Sinabung and quantify past activity. We compare digital elevation models (DEMs) spanning the eruption to estimate the volume of deposits from pyroclastic density currents and the volume of the 2014 lava flow that has collapsed since its emplacement. We utilize UAS-derived high-resolution topography to infer flow dynamics from lava flow surface morphology, and compare these results to direct observations of the lava flow during its emplacement. Future work will use UAS-derived DEMs to quantify the stability and continued collapse risk of the existing lava. While no new lava has appeared at the vent in over a year, a significant hazard remains. This study highlights the multiple ways data from UAS can be used to study and monitor active eruptions.

A vigorous 'jetting' Strombolian explosion ejects lava over 100 meters into the air at Stromboli Volcano, Italy.
Pic: Brett Carr

Poster Session Abstracts

Idealized Modeling of Vegetation-Atmosphere Interactions and the Green Sahara Paleoclimate State

Spencer Hill, Ocean & Climate Physics

The "Green Sahara" paleoclimate state within the Holocene – wherein proxy records indicate that appreciable precipitation and vegetation spanned far into the modern desert – is thought to be fundamentally driven by the precessional forcing signals of enhanced boreal summer insolation and its meridional gradient. However, climate models forced with these orbital changes typically fail to push rainfall sufficiently into the desert unless the corresponding vegetation changes are imposed through darkening the Saharan surface and/or increasing the surface water storage capacity. This poster presents ideas for future work using models ranging from simple box-type energy balance models to simplified climate models in order to determine the conditions necessary to generate the hydrological imprints of the Green Sahara state self-consistently. The energy balance model approach is a direct analog to those commonly used for high-latitude ice albedo feedbacks. Moving up in complexity to idealized climate models, we propose a novel, simple parameterization of vegetation's influences on surface albedo and hydrology.

Quantifying Regional-Scale Carbon Fluxes from Tundra Ecosystems: Insights from Recent Campaigns and Long Term Trends

Luke Schiferl, et al., Ocean & Climate Physics

The Arctic is warming at twice the rate of the global average, which has the potential to release vast stores of carbon-containing gases into the atmosphere, thereby accelerating warming. Understanding how ecosystems in these areas respond to climate change is key to the prediction of the future climate state. The goal of this study is to quantify changes in tundra carbon dioxide (CO_2) fluxes over recent and long-term time periods. First, we simulate a CO_2 flux field using a reformulated simple empirical carbon model driven by only light and heat. This model is tuned to eddy flux tower observations of CO_2 and associated meteorology. These relationships are scaled regionally using meteorological reanalysis information to produce a spatially and temporally varying flux product, with accompanying uncertainties, useful for a variety of applications. Second, we evaluate the model using the calculated surface influence on airborne and tower measurements of CO_2 concentration from a Lagrangian atmospheric transport model. Our analysis method allows us to identify the areas and sources which are not accurately represented by our light- and heat-driven model. This helps improve our understanding and representation of the carbon system in tundra ecosystems and how they are responding to changing temperatures.

Mapping Dark Ice and Ice Algal Blooms in Southwest Greenland from Satellite Imagery

Shujie Wang et al., Marine Geology & Geophysics

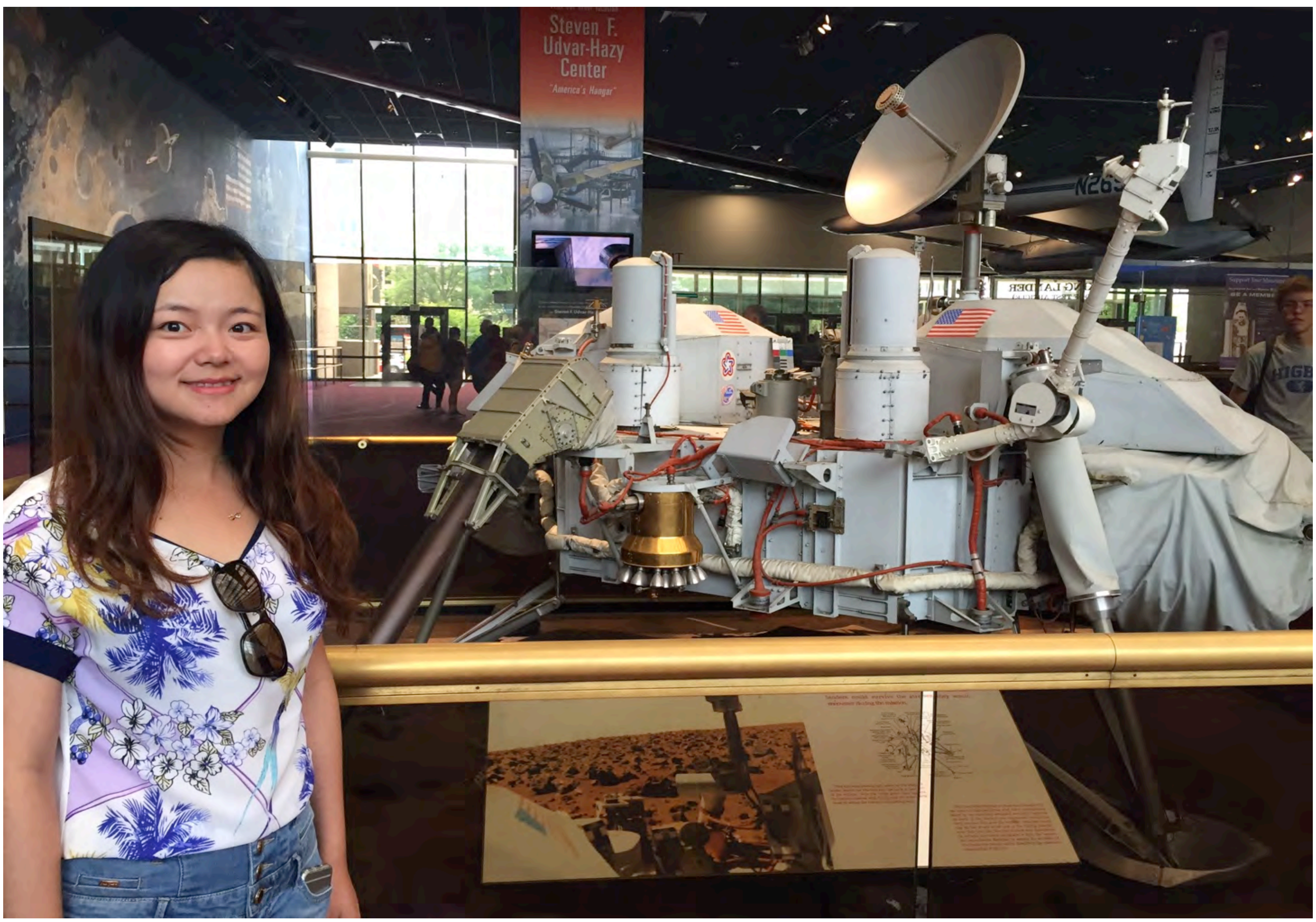
The presence of light-absorbing impurities affects the surface energy balance of snow and ice by reducing the shortwave albedos. Ice algae play a significant role in driving the surface darkening of the bare ice zone over the southwestern Greenland Ice Sheet during the summer melting season. Quantification of algal distribution and abundance is fundamentally important for understanding the temporal evolution of ice algal blooms and developing a bio-albedo scheme for better modeling the surface melting process in regional climate models. Field observations of ice algae in Greenland are very limited over space and time. It has been challenging to monitor the development of ice algae at a regional scale with temporally frequent observations. Here we use satellite tools which are designed for mapping chlorophyll-a to estimate the algal abundance at a regional scale. The spatial variation pattern revealed by satellite data is highly consistent with previous field observations. Incorporating the algal distribution derived from satellite data into regional climate models is expected to improve the projection of future mass balance over the Greenland ice sheet.

Poster Session Abstracts

A Data-Driven Method to Evaluate Subgrid Tracer Fluxes in Ocean Models

Mu Xu, Ocean & Climate Physics

Eddy transport of tracers (e.g. heat, salt, dissolved chemicals etc.) by mesoscale turbulence is important in climate models. However, the scales of eddy transport are about 10~200 km, which are not resolved by coarse-resolution global climate models. Consequently, the mesoscale tracer transports must be parameterized using a subgrid scheme. The goal of parameterization is to predict the tendencies of physical variables including velocity, temperature, salinity etc. due to the unresolved turbulent motions. There are many different types of mesoscale subgrid schemes and many different tuning parameters. However, evaluating the performance of subgrid scheme quantitatively is difficult. In this poster, we present a framework to evaluate the accuracy of subgrid schemes quantitatively with a data-driven method. We run a high-resolution simulation with resolution of about 5 km and consider this as our "truth". With a coarse-grain method, the high-resolution data is projected to a low-resolution grid. The quantitative aim of eddy parameterization is to mitigate the loss of tracer transport due to the coarse-graining. Based on this consideration, we develop an offline system to calculate the eddy parameterization predictions and evaluate the performance of different subgrid schemes. This work lays a foundation for future data-driven statistical-learning-based methods for ocean eddy tracer transport parameterization.



Shujie Wang in front of the Mars Rover in the Smithsonian National Air and Space Museum, Washington D.C.

Meet Our Postdoctoral Scientists

Patrick Alexander
Research: My research focuses on interactions between the cryosphere and climate, particularly on understanding and improving simulations of processes occurring at the surface of ice sheets and glaciers, with the goal of improving climate model projections of future ice sheet mass balance. I have worked on evaluating and improving simulations of ice sheet surface mass balance, albedo and near-surface densities in simulations with regional and global climate models.
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Division: Marine Geology & Geophysics

Julen Alvarez-Aramberri
Research: My main research experience lies in the area of computational and applied mathematics. In particular, in the efficient implementation of numerical methods and tools to efficiently model and interpret passive and active source electromagnetic (EM) problems. Currently, I focus on solving the direct and inverse problems arising in the Magnetotelluric and Controlled Source EM techniques, which are employed to retrieve information about the resistivity distribution of the Earth's subsurface.
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Division: Marine Geology & Geophysics

Weston Anderson
Research: Weston studies the dynamics of climate variability and its relation to food security using reanalysis products, remote sensing observations, and model simulations. He has been working on how global-scale modes of climate variability pose a correlated risk to major agricultural production regions, and how subseasonal-to-seasonal forecasts could be used in the agriculture sector. He is an Earth Institute Postdoctoral Fellow working on climate and food security.
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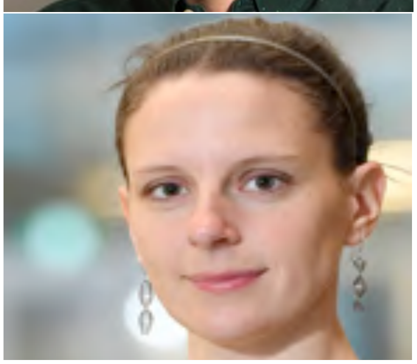

Erin Black
Research: My research focuses on improving our understanding of the cycling of elements in the modern ocean through observation-based studies. My aim is to elucidate the oceanic controls on global climate change by examining the factors influencing the biological carbon pump and by constraining the export of carbon via sinking particles. I am also investigating how the cycling of biologically-relevant trace elements, such as Fe, can influence (and be influenced by) the processes that constitute the biological carbon pump.
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Division: Geochemistry

Kasey Bolles
Research: I am an interdisciplinary climate scientist, with expertise in remote sensing, GIS & image analysis, and integration and analys is of disparate datasets through stochastic modeling. I study mechanisms of North American drought throughout the Late Holocene and impacts on environmental exposure to health hazards. My prior work examined the iconic 1930s Dust Bowl on the U.S. Great Plains. I am investigating "megadroughts" in the contiguous U.S. associated with the Medieval Climate Anomaly, and implications for the future in light of climate change.
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Division: Biology & Paleo Environment

Brian Boston

Research: Brian is a marine geophysicist. He received his PhD from the University of Hawaii, where he used multi-channel seismic reflection data and borehole geophysics to study the Nankai Trough and Japan Trench subduction zones. He then spent two years at the Japan Agency for Marine-Earth Science and Technology studying the rifting events that led to the formation of Zealandia, the submerged continent in the SW Pacific, using multi-channel seismic reflection and wide-angle seismic data.

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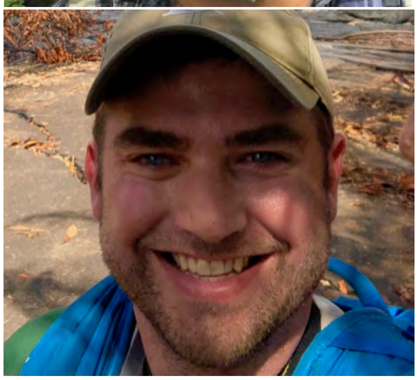

Brett Carr

Research: I am a volcanologist studying the physical processes driving volcanic eruptions. The primary goal of my research is to combine observational and numerical modeling techniques to develop a more complete understanding of active volcanism. I am interested in how prolonged eruptions progress over time and change their style of activity. At Lamont, I am focusing on the mechanisms controlling the stability and collapse of lava domes and how the size and frequency of these dangerous collapse events may be better anticipated. I am also developing new applications of using drones to observe volcanoes, particularly by applying drone based thermal imagery.

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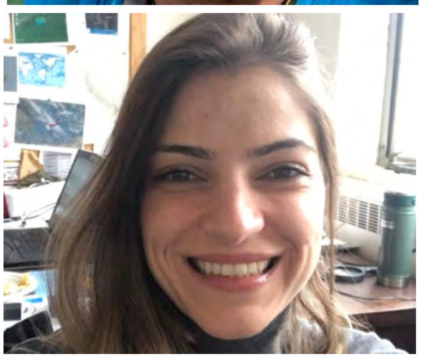

Renata Constantino Barrella

Research: I work on marine geophysical research and my current project is focused on gravity studies over Antarctica. I am current working on mapping the seafloor under the George VI Ice Shelf on the Antarctic Peninsula as well as mapping the oceanic basement (surface under the sediments) of the Ross Sea. Understanding these hidden surfaces improves our knowledge of the tectonic history of these areas.

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Division: Marine Geology & Geophysics

Stephen Cox

Research: My work spans various noble gas geo- and thermochronology techniques, including $^{40}Ar/^{39}Ar$, (U–Th)/Ne, $^{4}He/^{3}He$, and cosmogenic He and Ne. I am working on expanding the noble gas toolkit in the lab at Lamont. One research focus is Antarctica, where I study ice sheet history, landscape evolution, and subglacial geology using the chronology of bedrock samples and glacigenic sediments. Another is Kenya, where I work on dating basalt flows, paleo forests, and low temperature thermochronometers to study the East African Rift, the timing of early hominid evolution, and climate history

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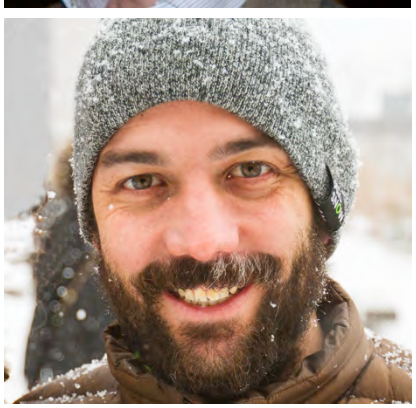

Juan Carlos de Obeso

Research: My research focuses on low temperature alteration of mantle rocks mainly hydration and carbonation. Currently I am working on carbonation at the leading edge of the mantle wedge using samples from the Oman Drilling Project. I use a variety of techniques including non-traditional stable (Mg), stable (C) and radiogenic (Sr) along with thermodynamic modeling to understand fluid fluxes and reactions from this ancient subduction zone.

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Division: Geochemistry

Blake Dyer

Research: I am driven by a deep curiosity to understand how Earth surface processes and sediments record critical moments in Earth history across time scales that include the early evolution of life to recent glacial-interglacial variability. To investigate this sedimentary record, I lead field campaigns to collect geospatial, geochemical and stratigraphic data. I work with modern data science tools, Bayesian statistics, and model building to extract a signal (and uncertainty) of past environmental change from this field data.

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Division: Biology and Paleo Environment

Jacqueline M. Goordial

Research: Jackie is an environmental microbiologist interested in how microscale processes effect global scale cycling, with a special interest in 'extreme' environments where microorganisms are the predominant or sole living organisms. Previously Jackie was at Bigelow Laboratory in Maine, where she used single cell sorting facilities in combination with activity probes and genomic sequencing to investigate the genomes of active microorganisms living within oceanic crust in two Mid-Atlantic Ridge sites. Jackie will be investigating the microbial influences on the fate of aged permafrost carbon upon rapid thaw in marine settings due to coastal permafrost erosion.

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Division: Biology & Paleo Environment

Julia Gottschalk

Research: My research seeks to identify impacts of physical, dynamical and biological processes in the Southern Ocean on millennial and orbital-scale atmospheric CO_2 and past climate variability, and how these were globally connected to climate variability. I apply various tools, primarily based on foraminifera shells, including reconstructing parameters of the ocean carbonate system, oxygenation, temperature and radiocarbon ventilation ages, to study global carbon cycle variations of the Pleistocene. I am investigating ocean carbon cycle dynamics during past interglacial periods, especially pathways by which oceans may have sequestered carbon from the atmosphere.

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Division: Geochemistry

Tatiana Gumucio

Research: Tatiana's research analyses how social differences such as gender, ethnicity and race influence smallholder farmers' risk perceptions, climate information needs, and capacities to respond and adapt to climate variability and change. Through collaborative and interdisciplinary work, her research seeks to inform effective and equitable decision-making and policymaking related to climate in the agricultural and food security sectors.

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Division: International Research Institute for Climate and Society

Winslow Hansen

Research: Winslow is a forest and ecosystem ecologist who seeks to understand whether forests will remain resilient to accelerating environmental change, where and why forest resilience may be eroded, and how novel forests will reorganize from the ashes of old systems. He is particularly interested in cross-scale interactions and feedbacks in forest ecosystems, including effects of forest change on continental-scale climate patterns, and how changing forest ecosystems can be sustainably managed. Much of his research uses Alaskan boreal forest as his study system.

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Division: Earth Institute/ Biology and Paleo Environment

J. Nicolás Hernandez-Aguilera
Research: Nicolás is an Earth Institute Fellow, member of the Financial Instruments Sector Team, and Columbia World Project: "Adapting Agriculture to Climate Today, for Tomorrow". His interest is in sustainable agricultural systems; his research focuses on understanding innovative ways to incentivize and scale-up smallholder's generation, translation, and use of climate information, to improve the co-design of financial tools for risk management. Nicolás has experience in the coffee sector, and modeling profitable agroecological cropping systems, and alternative business models.
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Division: Earth Institute/ International Research Institute for Climate and Society

Spencer Hill
Research: I am a climate scientist specializing in tropical atmospheric dynamics. My work at Lamont will focus on the Indian Monsoon, specifically on improving seasonal and interannual forecasts of monsoon rainfall and the communication of those forecasts to relevant local stakeholders in India. This work is part of a larger collaboration with the Indian Meteorological Department and relies on a combination of climate model simulations, theoretical work, and analyses of observational data.
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Division: Earth Institute/ Ocean & Climate Physics

Sophie Hines
Research: The primary goal of my research is understanding the connection between ocean circulation and climate over glacial-interglacial cycles. I use geochemical proxies to reconstruct changes in past ocean circulation and I have developed a simple isopycnal model to investigate the ocean dynamics during the glacial, and particularly across abrupt climate change events. I am using neodymium isotopes to investigate deep circulation changes in the Cape Basin and their relation to the Agulhas Leakage, which brings warm salty surface water from the Indian into the Atlantic Ocean.
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Division: Geochemistry

Mark Hoggard
Research: My research focuses on the impact of solid Earth deformation on the rock record. Areas of active research include the effect of mantle convection on landscape evolution, sediment routing systems and long-term climate evolution. Working jointly between Lamont and Harvard, I have been focusing on the relationship between lithospheric structure and giant mineral deposits hosted in sedimentary basins.
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Division: Seismology, Geology and Tectonophysics

Emily Hopper
Research: My doctoral research focused on the seismic structure of the crust and lithospheric mantle across the U.S. Since coming to Lamont, I have been primarily focused on the East African Rift and the Pacific Ocean, including a month at sea deploying seismometers. I'm currently co-PI on a project to develop a new joint inversion of surface waves constrained by receiver functions.
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Division: Seismology, Geology & Tectonophysics

Spencer Jones
Research: I use a combination of theory and ocean modeling to explore the effect of ocean dynamics on tracer transport. I am working towards a more complete understanding of the distribution of physical and chemical ocean tracers, with the goal of predicting the response of ocean tracer transport to changes in atmospheric conditions.
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Division: Ocean & Climate Physics

Alexandra Karambelas
Research: I use chemical transport models to understand and evaluate the links between energy, emissions, air quality, climate, and human health outcomes in India. Through this research, I seek to quantify contributions from various anthropogenic emissions sectors to ambient pollution concentrations and human health outcomes in the region and determine potential sectors for future mitigation.
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Division: Earth Institute/ Ocean & Climate Physics

Kai Korhuber
Research: Kai's research is dedicated to the internal mechanisms of large-scale atmospheric circulation and their relation to extreme weather in the mid-latitudes. With a focus on atmosphere dynamics he investigates drivers, impacts, and future risks of extreme climatic events such as heat waves, droughts, heavy rainfall, and floods. Kai investigates future risks of simultaneous extreme weather events over breadbasket regions under different warming scenarios. Kai was a postdoc at Oxford and a researcher at the Climate & Energy College at Melbourne. Kai sees public outreach about climate issues as an important and inspiring element of his work.
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Division: Earth Institute/ Ocean and Climate Physics

Ching-Yao Lai
Research: My interests include both physics-based and machine learning models for applications centered around energy and climate. I work across disciplinary lines, seek the missing pieces in climate predictions and aim to use science and data to inform public policy.
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Division: Marine Geology & Geophysics

Nathan Laxague
Research: I study physical processes at the air-sea interface. I am an observationalist; I make field and laboratory measurements and use them to explore the small-scale fluid mechanical interactions between the Earth's atmosphere and oceans. My particular area of interest is in short-scale wind waves and their mediation of air-sea momentum, heat, and mass flux.
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Division: Ocean & Climate Physics

Rachel Lupien

Research: I am an organic geochemist interested in African climate history and the role of environmental change on hominin evolution. I use leaf wax biomarker isotopes to reconstruct paleoclimate from the Plio-Pleistocene and then employ time series and statistical analyses to quantify trends and cycles to study evolutionary hypotheses and global climate teleconnections. At Lamont I will be applying similar techniques to marine sediment cores to study the extent of monsoonal strength and weakness recorded in bi-modal Mediterranean sapropel layers.

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Division: Biology & Paleo Environment

Jennifer Middleton

Research: I use inorganic geochemical proxies (including trace elements, U-series, and noble gases) to study the relationships between climatic variability, ice sheet stability, and the global carbon cycle within the paleorecord. At Lamont I am investigating how millennial-scale variations in iron input to the Southern Ocean from continental dust and ice rafted debris affect the efficiency of the biologic carbon pump and marine uptake of atmospheric carbon dioxide.

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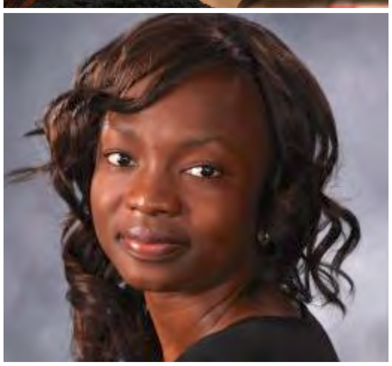

Elisabeth Nébié

Research: Elisabeth is a human ecologist who has conducted research on farmer-herder livelihoods, challenges and adaptations in the Center-South region of Burkina Faso. As an Earth Institute fellow, Elisabeth works to document the relationship between the 're-greening' of the West African Sahel and food security trends. She documents the use of indigenous knowledge in pastoralists' decision-making on their seasonal mobility, and explores how this knowledge can be integrated with climate science as scientists and pastoralists look for the best ways to adapt to climate change.

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Division: Earth Institute/ International Research Institute for Climate & Society

Paulina Pinedo Gonzalez

Research: I am a chemical oceanographer. My research is focused on generating new data on biologically essential and anthropogenic metals in a wide variety of marine environments (i.e. North Pacific, Southern Ocean, and Arctic Ocean) to investigate the physico-chemical and biological influences that interact to control metal biogeochemistry in the ocean. I'm also interested in applying trace metal isotopes as proxies to understand the cycling of metals in the ocean (i.e. Fe, Th, Pa, Nd and Pb isotopes).

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Division: Geochemistry

Robert Poirier

Research: My research interests and expertise involve micropaleontology and Quaternary Geology, with experience in geochronology and paleoceanography. I am primarily interested in interactions between various components of the global climate system during periods of major change. My work at Lamont has focused on assessing the impact of diagenesis on the geochemical composition of shells belonging to benthic foraminifera species commonly used to construct deep-sea climate records. Data from these records are the principal means to reconstruct long term changes in ice volume and sea level.

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Division: Biology & Paleo Environment

Diego Pons
Research: My research interest lies in the generation of climate services in developing countries. I'm interested in generating with and communicating actionable climate information to vulnerable communities in tropical settings. I make use of dendrochronology to assess decadal climate variability and to integrate this into risk management strategies. Currently my research focuses on seasonal to sub-seasonal climate processes and their impact on agriculture and food security.
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Division: International Research Institute for Climate & Society

Milagros Rodríguez-Catón
Research: My research interest is focused on ecology and palaeoenvironment. I'm developing an isotopic tree-ring network from Polylepis tarapacana, the highest elevation tree-ring record in the world, located in the Altiplano in South America. The aim of this study is to build a reconstruction of climate variables such as temperature and precipitation near the tropics, as well as providing insights on ecophysiological questions related to tree-ring research
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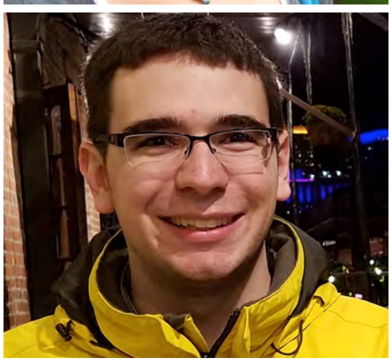
Division: Biology & Paleo Environment



Rick Russotto
Research: I am generally interested in clouds, atmospheric radiation, and large-scale atmospheric circulation, and how these things change under various climate forcings. My Ph.D. research covered these questions in the context of solar geoengineering. At Lamont, I am studying similar questions in a set of model experiments, TRACMIP, involving an idealized, ocean-covered world with an optional rectangular continent.
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Division: Ocean & Climate Physics

Seth Saltiel
Research: Seth is interested in slip and frictional drag processes in a range of geological settings. He helped develop a seismic frequency apparatus to measure shear modulus and attenuation under varying normal stress, finding a nonlinear elastic signature of frictional slip initiation. The data required a novel friction law, which he later explored in the context of earthquake rupture in Chile. Seth will be investigating subglacial seismicity and slip processes, and will measure frictional properties of ice on till interfaces under the range of expected subglacial conditions.
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Division: Seismology, Geology & Tectonophysics

Naomi Saunders
Research: I am a non-traditional stable isotope geochemist, recently graduated from my PhD on stable Ni isotopic fractionation in high temperature terrestrial and lunar rocks from Oxford University, UK. My future research is working on further investigating significant observations of my PhD, with stable Ni isotope to be obtained from a larger range of high temperature lithologies and geological localities, and modeling.
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Division: Geochemistry

Luke Schiferl
Research: My work in atmospheric chemistry focuses broadly on biosphere-atmosphere interactions. I have studied the relationship between air quality and agriculture using satellite, ground, and aircraft measurements along with chemical and crop production models. I am working on various projects including improving our understanding of the carbon system in the Arctic, updating the global representation of indicators of biogenic activity, and investigating changing African industrial and fire emissions.
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Division: Ocean & Climate Physics

Laura A. Stevens
Research: My research focuses on ice-sheet dynamics, in order to better understand the physical mechanisms that destabilize ice sheets with increased surface meltwater production. I have used geophysical observations paired with inverse methods and computational modeling to investigate supraglacial lake drainages, decadal ice-flow variability, subglacial hydrology, subglacial discharge plumes in fjords, and tidal- and meltwater-forced flow of outlet glaciers. I am about to embark on a new field campaign to the George VI Ice Shelf, Antarctic Peninsula, to investigate flexure and fracture of ice shelves in response to surface meltwater loading.
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Division: Marine Geology & Geophysics

Andy Stock
Research: Andy draws on geoinformatics and computer science to solve problems in marine ecology. He uses machine learning methods to extract information about plankton community composition from satellite images. For his doctoral studies Andy investigated uncertainty in maps of human impact on marine ecosystems. Before returning to academia, he was an environmental consultant, software developer, and cartographer.
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Division: Earth Institute/ Biology & Paleo Environment

Jeffrey Strong
Research: I work on tropical cyclones and their place in the tropical climate as a whole. My primary work involves collaborating with the NASA Goddard Institute for Space Studies in developing the next generation of their global climate model while analyzing and improving it's ability to represent tropical cyclones around the globe. My Ph.D. work concerned similar research in another model alongside how tropical cyclones are affected by aerosol emissions, a research goal which continues at Lamont.
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Division: Ocean & Climate Physics

Roberto Suarez Moreno
Research: My research interests focuse on climate variability and change from seasonal to multidecadal time scales. I'm particularly interested on sea surface temperature (SST)-forced teleconnections and associated impacts on hydroclimate. I use both numerical models, observations and reanalysis to understand the physical mechanisms underlying climate variability and change. Up to now, my research has been focused on the West African Sahel. At Lamont I'm working on hydroclimate variability over the Mediterranean to uncover the mechanisms of hydroclimate variability and change over the Mediterranean region.
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Division: Ocean & Climate Physics

Shujie Wang
Research: My current research focuses on quantifying the impacts of different impurities, particularly the ice algae, on the Greenland Ice Sheet albedo. I use various remote sensing datasets and regional climate models to understand the albedo-reducing effects of ice algae on surface mass balance of the Greenland Ice Sheet. I previously worked on using optical, SAR and altimetry remote sensing datasets as well as ice flow models to study the flow dynamics and stability of the Larsen Ice Shelf in Antarctic Peninsula over the past half century.
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Division: Marine Geology and Geophysics

Martin Wearing
Research: My work focuses on understanding the dynamics of ice sheets, with the aim of improving predictions of their future contributions to sea-level rise. I'm particularly interested in the role of ice shelves – the floating extensions of ice sheets. They are crucial for providing resistance to the flow of grounded ice. I use a number of tools to help improve understanding: idealized mathematical models; laboratory-scale fluid-mechanical experiments; and analysis of geophysical data, such as ice-surface velocities and ice-penetrating radar.
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Division: Marine Geology & Geophysics

Yingzhe Wu
Research: My research interest is to understand the sources, sinks, and cycling of trace elements (focusing on rare earth elements) in the modern ocean. I also investigate how well neodymium (one of the rare earth elements) isotopes can be used as a conservative water mass tracer. It will help us better understand the behavior of rare earth elements and neodymium isotopes in seawater and serve as a basis for reconstructions of paleo-ocean circulation.
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Division: Geochemistry

Honghai Zhang
Research: I am a climatologist with research interests in climate dynamics and hydroclimate. I have been investigating the causes of regional rainfall variability over North America, particularly, the role of ocean variability. At Lamont, I focus on the tropical Pacific and investigate the observed variability and changes. My approach is mainly numerical, including both simple linear dynamical models and complex global climate models.
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Division: Ocean & Climate Physics

Sha Zhou
Research: Sha has broad research interests, including water resources management, carbon and water cycling, and atmosphere-biosphere interactions. Her dissertation focused on terrestrial water use efficiency and its application for evapotranspiration partitioning. She proposed a new partitioning method to separate plant transpiration from evaporation. Her current work aims to improve water productivity and resilience of the societal-ecological system in water catchments. She will develop a global database of actual water demand and a knowledge base for catchment management to underpin global sustainable water management.
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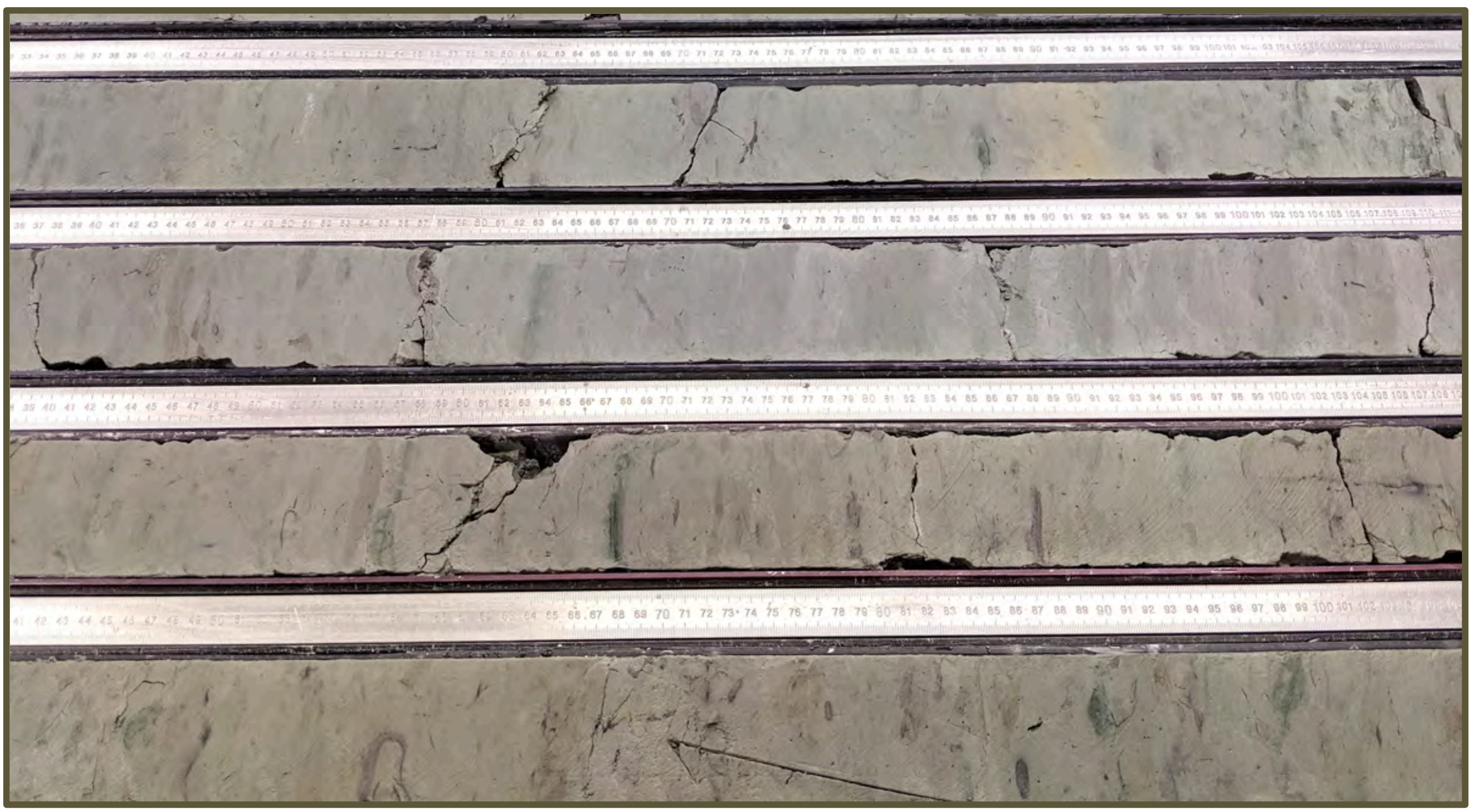
Division: Earth Institute/ Ocean & Climate Physics

Notes

Nothofagus pumilio trees in the Santa Cruz province of Patagonia, Argentina. Pic: Milagros Rodríguez-Catón

Notes



New sediment cores from IODP Expedition 383 from the South Pacific Ocean. Pic: Jennifer Middleton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